

Supporting Information for Publication

**One Step Synthesis of Ethyl Levulinate Biofuel by Ethanolysis of Renewable Furfuryl
Alcohol over Hierarchical Zeolite Catalyst**

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Table S1. The Box-Behnken design matrix of the three process variables in coded units and the experimental and predicted response values.

Run	Process variables in coded units			EL Yield, Y (%)		EMF Yield (%)
	X ₁	X ₂	X ₃	Experimental	Predicted	
1	+	0	+	48	47.8	47
2	0	+	+	73	72.2	24
3	0	0	0	54	54	39
4	0	0	0	54	54	39
5	+	-	0	27	27.5	68
6	-	+	0	68	67.5	26
7	0	-	+	43	42.8	44
8	-	0	-	57	57.2	37
9	0	0	0	54	54	39
10	0	0	0	54	54	39
11	-	-	0	53	52	45
12	0	-	-	41	41.8	49
13	+	0	-	42	40.8	52
14	0	0	0	54	54	39
15	-	0	+	62	63.2	31
16	+	+	0	59	60	36
17	0	+	-	60	60.2	37

Table S2. ANOVA for response surface quadratic model.

Source	Sum of squares	Df	Mean square	F-value	p-value Prob > F	
Model	1870.76	9	207.86	207.86	< 0.0001	significant
X ₁	512	1	512	512	< 0.0001	
X ₂	1152	1	1152	1152	< 0.0001	
X ₃	84.5	1	84.5	84.5	< 0.0001	
X ₁ X ₂	72.25	1	72.25	72.25	< 0.0001	
X ₁ X ₃	0.25	1	0.25	0.25	0.6324	
X ₂ X ₃	30.25	1	30.25	30.25	0.0009	
X ₁ ²	19.01	1	19.01	19.01	0.0033	
X ₂ ²	0.066	1	0.066	0.066	0.8049	
X ₃ ²	0.59	1	0.59	0.59	0.4668	
Residual	7	7	1			
Lack of Fit	7	3	2.33			
Pure Error	0	4	0			
Cor Total	1877.76	16				

R² = 0.9963; R²-adjusted = 0.9915; R²-predicted = 0.9404; CV = 1.88%;

Adequate precision = 58.35.

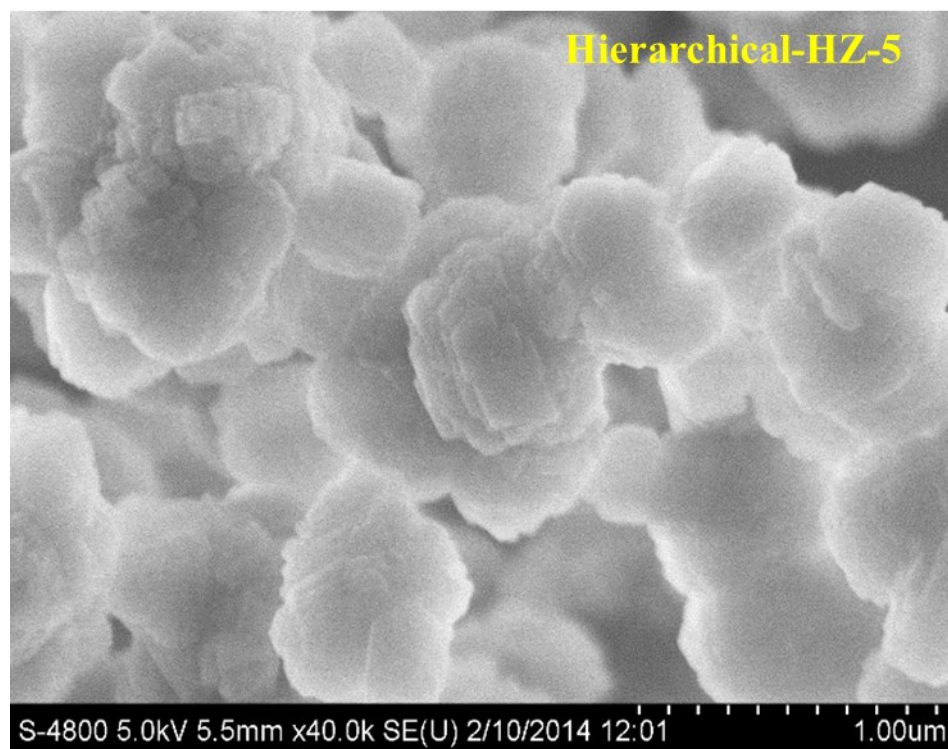


Fig. S1: FE-SEM images of H-ZSM-5 and Hierarchical-HZ-5 catalyst.